85 4356

FOREST PEST MANAGEMENT
Pacific Southwest Region

Report No. 85-22

3430 Evaluation
September 13, 1985

A BIOLOGICAL EVALUATION OF BLACK STAIN ROOT DISEASE AND ASSOCIATED PESTS IN THE TIMBER MOUNTAIN AREA, DOUBLEHEAD RANGER DISTRICT, MODOC NATIONAL FOREST

John Kliejunas, Plant Pathologist

ABSTRACT

Black stain root disease, as well as dwarf mistletoe, mountain pine, western pine, and red turpentine beetles, were associated with dead and dying ponderosa pines in the Timber Mountain area. Pest biologies are presented. Management alternatives discussed include no change in current management direction, thin the existing stand, remove pines from the root disease center and create a buffer strip, and species conversion.

INTRODUCTION

During a visit to the Doublehead Ranger District on July 8-10, 1985, the District requested an evaluation of a root disease center on Timber Mountain. Annosus root disease was suspected as the cause. I was accompanied by District Timber Management Officer Jim Leoni and District Culturist John King. The objective of the evaluation was to determine the pests associated with the dead and dying trees and to provide the District with available alternatives to reduce potential impact of pests.

OBSERVATIONS

The area examined (T. 44 N., R. 6 E., Sec. 21) is within a second growth stand of pure ponderosa pine. Much of the stand is overstocked, below commercial size, and contains a few sawtimber-sized trees. Understory vegetation consists primarily of bitterbrush.

Dead, often windthrown, trees as well as trees in various stages of decline were present. Foliage symptoms, including thin and chlorotic crowns, reduced terminal growth, and poor needle retention, suggested the presence of a root disease. A dark brown to black stain following the annual rings in arcs in sapwood of roots and root crowns confirmed the presence of black stain root

disease, caused by Ceratocystis wageneri. Many of the dead and dying trees had been successfully attacked by the western pine beetle (Dendroctonus brevicomis), mountain pine beetle (D. ponderosae), and the red turpentine beetle (D. valens). Western dwarf mistletoe (Arceuthobium campylopodum) infection levels were light to moderate throughout the stand. District Culturist John King indicated that other centers of dead and dying pines with characteristics similar to those observed in this stand were scattered throughout both National Forest and private lands in the Timber Mountain Area.

PEST BIOLOGIES

Black Stain Root Disease

Black stain root disease is caused by the fungus Ceratocystis wageneri (imperfect state Verticicladiella wageneri). In California, the fungus has three host-specific strains that infect either (1) ponderosa and Jeffrey pine, (2) singleleaf pinyon pine, or (3) Douglas-fir. In most situations, the fungus does not cross-over between species, even in mixed species stands. True firs, incense-cedar, redwood, giant sequoia, and junipers are resistant.

Initiation of disease centers probably occurs when spore-carrying, cambium-feeding beetles invade tree roots. While feeding on the root system, the insects introduce the spores into the vascular system of the tree. The fungus then grows in the wood of the root toward the root collar.

Once the fungus becomes established in the roots, it spreads locally between trees through rootlet contact or by moving short distances through soil to infect small rootlets. The rate of underground spread in a ponderosa pine stand is highly variable and dependent on species composition, stand density, and site. On the Georgetown Divide, El Dorado County, the average annual radial spread was 4 feet (range 0 to 20 feet). Even though the fungus spreads through the root systems of living trees, it rarely spreads, or even survives, in roots after the infected tree dies.
The disease can be identified in a tree by the dark brown to black stain of the wood. This stain occurs as arcs that correspond with the annual rings. The stain may occupy very little to most of the circumference of the tree and may be from one to many annual rings deep.

Infected trees undergo gradual to rapid crown decline prior to mortality. Symptoms of crown decline include reduced terminal growth, needle yellowing and shortening, and premature loss of foliage. Trees pole-size and larger may also bear a heavy cone crop. Bark and engraver beetles can successfully attack and kill infected trees. Douglas-firs may have grayish-blue resin streaming from the bark above the stained area.

Little information is available on stand and site characteristics associated with the disease. On the Georgetown Divide, pure or predominant ponderosa pine stands with moderate to high stand densities had a higher probability of being infected. The disease appeared to be limited to an elevational band of 4000 to 5000 feet. A characteristic of the disease in Douglas-fir is its higher incidence along roads and in young plantations or dense natural regeneration.

Dwarf Mistletoes

Dwarf mistletoes (*Arceuthobium* spp.) are parasitic, flowering plants that can only survive on living conifers in the Pinaceae. They obtain most of their nutrients and all of their water and minerals from their hosts. Some infect only a single conifer species, while others may attack three or four that are closely related. They rarely cross-infect from one conifer genus to another. Because of their host specificity, *Arceuthobium* species can usually be identified by the hosts they infect.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and fall from the aerial shoots, and the seeds are forcibly discharged. The seed is covered with a sticky substance and adheres to whatever it contacts. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seeds is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. Because of the limits to seed dispersal and the parasite's long life cycle, the actual spread rate through an even-aged stand is usually 1-2 feet per year.

Vertical spread within tree crowns varies from about three inches per year in true firs, to two feet per year in Digger pines. In general, host vigor governs the rate of dwarf mistletoe intensification: dense, healthy foliage impedes vertical spread, while thin crowns are less of a barrier to the seed's upward movement.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow-green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached, and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings. In red fir, branch flagging usually indicates mistletoe-infected branches that have been attacked by the Cytospora canker fungus.

Western Pine Beetle

The western pine beetle, *Dendroctonus brevicomis*, breeds in the main bole of living ponderosa and Coulter pine larger than about 4 inches dbh. Normally it breeds in trees weakened by drought, overstocking, root disease, dwarf mistletoe or fire.

Adult beetles emerge and attack trees continuously from spring through fall. Depending on the latitude and elevation, there can be from one to four generations per year. The generations are difficult to distinguish because the prolonged period of initial attack and re-emergence of parent females to establish additional broods causes considerable overlapping of the generations.

Initial attacks are made about mid-bole and subsequent attacks fill in above and below. Pheromones released during a successful attack attract other western pine beetles. Attacking beetles may spill over onto nearby apparently healthy trees and overwhelm them by sheer numbers. Pitch tubes and red boring dust are indications of successful attacks.

Adults bore a sinuous gallery pattern in the cambium and the female lays eggs in niches along the sides. The larvae feed in the inner bark for a short distance and then turn into the outer bark to complete development.

Bluestain fungi introduced during successful attacks probably contribute to the rapid mortality associated with bark beetle attacks.

Woodpeckers, predaceous beetles and low winter temperatures cause natural control. Silvicultural activities that result in rapid, vigorous tree growth increases tree resistance and prevents mortality. Individual high value trees undergoing a temporary reversible stress, such as drought, can be protected for up to a year by applying insecticides to the bole.

Mountain Pine Beetle

The mountain pine beetle, Dendroctonus ponderosae, attacks the bole of ponderosa, lodgepole, sugar and western white pines larger than about 4 inches dbh. Extensive infestations have occurred in mature lodgepole pine forests. Group killing often occurs in mature forests and young overstocked stands of ponderosa, sugar and western white pines.

The life cycle of the mountain pine beetle varies considerably over its range. One generation per year is the general rule, with attacks occurring from late June through August. Two generations per year may develop in low elevation sugar pine.

Attacks may extend from the root collar up to near the top. Pheromones released during a successful attack may attract enough beetles to result in a group kill. Pitch tubes and red boring dust in bark crevices or on the ground indicate successful attacks.

The adults bore long vertical egg galleries and lay eggs in niches along the sides of the gallery. A "J"-hook is common at the lower end of the gallery. The hatching larvae feed in mines perpendicular to the main gallery and construct small pupal cells at the end of these mines where they pupate and transform into adults.

The sapwood of successfully attacked trees soon becomes heavily bluestained. The bluestain fungi probably aid in overcoming the defenses of the host tree.

Natural factors affecting the abundance of the mountain pine beetle include low winter temperatures, nematodes, woodpeckers and predaceous and parasitic insects. As stand susceptibility to the beetle increases because of age, overstocking, diseases or drought, the effectiveness of natural control decreases snd mortality increases. Relieving stress by thinning dense stands can prevent some group kills. Individual high value trees undergoing temporary reversible stress may be protected from attack by application of insecticide to the bole.

Red Turpentine Beetle

The red turpentine beetle, Dendroctonus valens, occurs throughout California and can breed in all species of pines. It normally attacks injured, weakened or dying trees and freshly cut stumps. The adults are attracted by fresh pine resin. They often attack wounded trees in campgrounds or following logging, trees scorched by wildfire or prescribed burns, lightning-struck trees and root-diseased trees exhibiting resinosis.

Attacks usually occur at the soil line or root crown and are characterized by a large reddish pitch tube at the point of entry. On severely stressed trees or during periods of drought, attacks may occur underground on the main roots up to 15 feet from the bole and also on the bole to a height of 10 feet. If an attack is successful, the adults excavate an irregular gallery in the cambium and the female lays eggs along the sides. The larvae feed in a mass and destroy an area of cambium ranging from 0.1 to 1.0 square feet. Attacks do not always kill trees but may predispose them to attack by other bark beetles. Repeated or extensive attacks by the red turpentine beetle can kill pines.

Attacks occur throughout warm weather and peak at mid-summer. The number of generations varies from two years for a single generation at the coldest portions of its range to two or three per year in the warmest.

Attacks can be minimized or prevented by avoiding soil compaction and injury to standing trees during logging or construction and also by insecticide application to high value trees.

MANAGEMENT ALTERNATIVES

No immediate management actions to control black stain are currently being considered in the area examined because the disease is not now affecting commercial size trees and because of other District priorities. However, various management alternatives to reduce the potential impact of the disease and associated pests are available for future consideration.

1. No Change in Current Management Direction. Black stain root disease will spread to adjacent trees, resulting in a continuing enlargement of the disease center until host-free barriers are reached. Mortality will continue along disease center margins over a period of years. Bark beetles attracted by pheromones toward trees already under attack will result in attack and killing of some trees outside the expanding center. Some trees within the center will escape root disease or bark beetle attack and reach merchantable size. Ponderosa pine may seed into the middle of the center as the disease dies out.

2. Thin the Existing Stand. The center and surrounding stand is scheduled for precommercial thinning in the next few years. Reducing the basal area will aid in reducing bark beetle-caused mortality of stressed trees and may aid in reducing the spread of the black stain fungus by increasing the distance the fungus must travel through living roots. Thinning would be an effective control for black stain only if spacing was wide enough to prevent root contact.

When thinning, trees infected with dwarf mistletoe should be considered for removal over non-infected trees. Removing the most severely infected trees (Hawksworth dwarf mistletoe ratings of 5 and 6) in the first entry will leave only lightly infected trees. Following release, these lightly infected residual pines may vertically outgrow the dwarf mistletoe if infections are confined to the lower one-third of the crown, and may be capable of reaching merchantible size by the time commercial thinnings are scheduled.

Remove Pines From the Center and Create a Buffer Strip. The radial spread of black stain infection centers can be limited by the felling of all hosts in a strip 75 feet wide around the outer limits of such centers. The intent of the buffer is to prevent the spread of the black stain fungus via root contact to adjoining stands. Even though underground spread of the fungus may be halted, the number of trees lost when creating the buffer strip might be greater than the number lost to the disease, at least in the short-term. Removing the host from the disease center will cause the fungus to die out after a period of three to five years. The site could then be regenerated with pines.

4. Species Conversion. Planting nonsusceptible hosts is a viable option in some California forests, but may not be practical on Timber Mountain. Being in the ponderosa pine/sagebrush type, the only other feasible species to plant may be incense-cedar, which is resistant to black stain. Western juniper is also resistant to black stain and would probably survive, but it is not currently a timber target species.